

## ONE-WAY ANOVA

To perform an ANOVA using one between-subjects factor, specify the dependent variable (here, ach100) and what factor to use (here, grp4). The second line shown below requests descriptive statistics and Levene's test of homogeneity of variance. The third line requests Tukey's post-hoc comparison of means in case a statistically reliable *F* test is obtained.

```
oneway ach100 by grp4
  /stats desc homo
  /posthoc = tukey .
```

## Oneway

### Descriptives

Achievement, 100 cases

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
4 SP	26	.43835	6.8524E-02	1.344E-02	.41068	.46603
2 SP	27	.40403	5.6030E-02	1.078E-02	.38186	.42619
2 SP, 3 WP	27	.33447	9.0051E-02	1.733E-02	.29884	.37009
2 SP, 6 WP	26	.34107	8.7998E-02	1.726E-02	.30553	.37662
Total	106	.37929	8.7445E-02	8.493E-03	.36245	.39613

### Descriptives

Achievement, 100 cases

	Minimum	Maximum
4 SP	.235	.566
2 SP	.217	.484
2 SP, 3 WP	.134	.449
2 SP, 6 WP	.090	.468
Total	.090	.566

The first part of the output shows you the sample size, mean, standard deviation, and standard error for the dependent variable at each level of the factor.

## Test of Homogeneity of Variances

Achievement, 100 cases

Levene Statistic	df1	df2	Sig.
2.043	3	102	.113

The second part of the output suggests whether group variances are approximately equal. As a rule of thumb, if the p value associated with Levene's test of homogeneity of variance is greater than .05, you can treat the group variances as comparable; if the p value is less than .05, this suggests that group variances differ appreciably.

## ANOVA

Achievement, 100 cases

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.199	3	6.648E-02	11.238	.000
Within Groups	.603	102	5.916E-03		
Total	.803	105			

The third part of the output provides a standard ANOVA summary table, including SS, df, MS, F, and p (labeled "Sig"):  $F(3, 102) = 11.24$ ,  $p < .001$ , revealing some group difference.

An Error Bar Graph can be useful for visually inspecting group differences.

In order to determine which groups differ from one another, a post-hoc test needs to be conducted. Below, Tukey's test is illustrated. The results are presented in two ways, each of which provides the same information.

In the "Multiple Comparisons" table, all possible pairs of groups are compared to one another. If you look at the p value for each comparison (labeled "Sig."), you can tell whether the two groups compared on that line differ reliably. In the example below, you could tell that all groups differ from one another with two exceptions: "4 SP" does not differ from "2 SP," and "2 SP, 3 WP" does not differ from "2 SP, 6 SP".

This information is presented in another form in the "Homogeneous Subsets" table. To read this table, any groups whose means appear in the same column do not differ reliably, whereas any groups whose means appear in different columns do differ reliably. This leads to the same conclusion as above: the "2 SP" and "4 SP" groups do not differ from one another, but each differs from the "2 SP, 3 WP" and "2 SP, 6 WP" groups, which in turn do not differ from one another. (It is a worthwhile exercise to verify for yourself that you reach identical conclusions using either table of post-hoc results.)

## Post Hoc Tests

### Multiple Comparisons

Dependent Variable: Achievement, 100 cases

Tukey HSD

(I) Exp. group	(J) Exp. group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
4 SP	2 SP	3.4324E-02	2.113E-02	.370	-2.08766E-02	8.9525E-02
	2 SP, 3 WP	.10389*	2.113E-02	.000	4.8686E-02	.15909
	2 SP, 6 WP	9.7281E-02*	2.133E-02	.000	4.1562E-02	.15300
2 SP	4 SP	-3.43242E-02	2.113E-02	.370	-8.95250E-02	2.0877E-02
	2 SP, 3 WP	6.9563E-02*	2.093E-02	.007	1.4885E-02	.12424
	2 SP, 6 WP	6.2957E-02*	2.113E-02	.019	7.7557E-03	.11816
2 SP, 3 WP	4 SP	-.10389*	2.113E-02	.000	-.15909	-4.86864E-02
	2 SP	-6.95630E-02*	2.093E-02	.007	-.12424	-1.48854E-02
	2 SP, 6 WP	-6.60641E-03	2.113E-02	.989	-6.18072E-02	4.8594E-02
2 SP, 6 WP	4 SP	-9.72808E-02*	2.133E-02	.000	-.15300	-4.15616E-02
	2 SP	-6.29566E-02*	2.113E-02	.019	-.11816	-7.75573E-03
	2 SP, 3 WP	6.6064E-03	2.113E-02	.989	-4.85944E-02	6.1807E-02

\*. The mean difference is significant at the .050 level.

### Homogeneous Subsets

Achievement, 100 cases

Tukey HSD<sup>a,b</sup>

Exp. group	N	Subset for alpha = .050	
		1	2
2 SP, 3 WP	27	.33447	
2 SP, 6 WP	26	.34107	
2 SP	27		.40403
4 SP	26		.43835
Sig.		.989	.370

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 26.491.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.